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(54) **Large capacity recording medium, method and apparatus for reproducing data from a large-capacity recording medium, and method and apparatus for recording data on a large-capacity recording media**

(57) Recorded at high density on an optical disk (10) are at least one title set (84, 86) and a volume information file (82). The title set consists (84, 86) of a plurality of files (88) aligned on a boundary between logical sectors. The files (88) store title set management information and data objects to be reproduced. The retrieve data from the optical disk (10), volume file information is read out, thereby acquiring information about the desired title set (84, 86). Then, the information for indicating steps or reproducing the data object and managing the desired title set (84, 86) is acquired. Using the title set management information, data is reproduced from the optical disk (10).

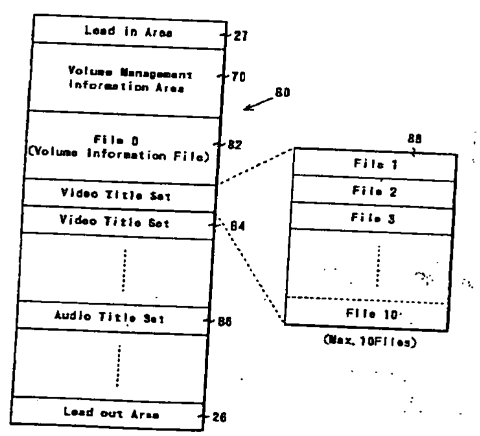

FIG. 4

EP 0 714 098 A2

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2 11.7/3.4

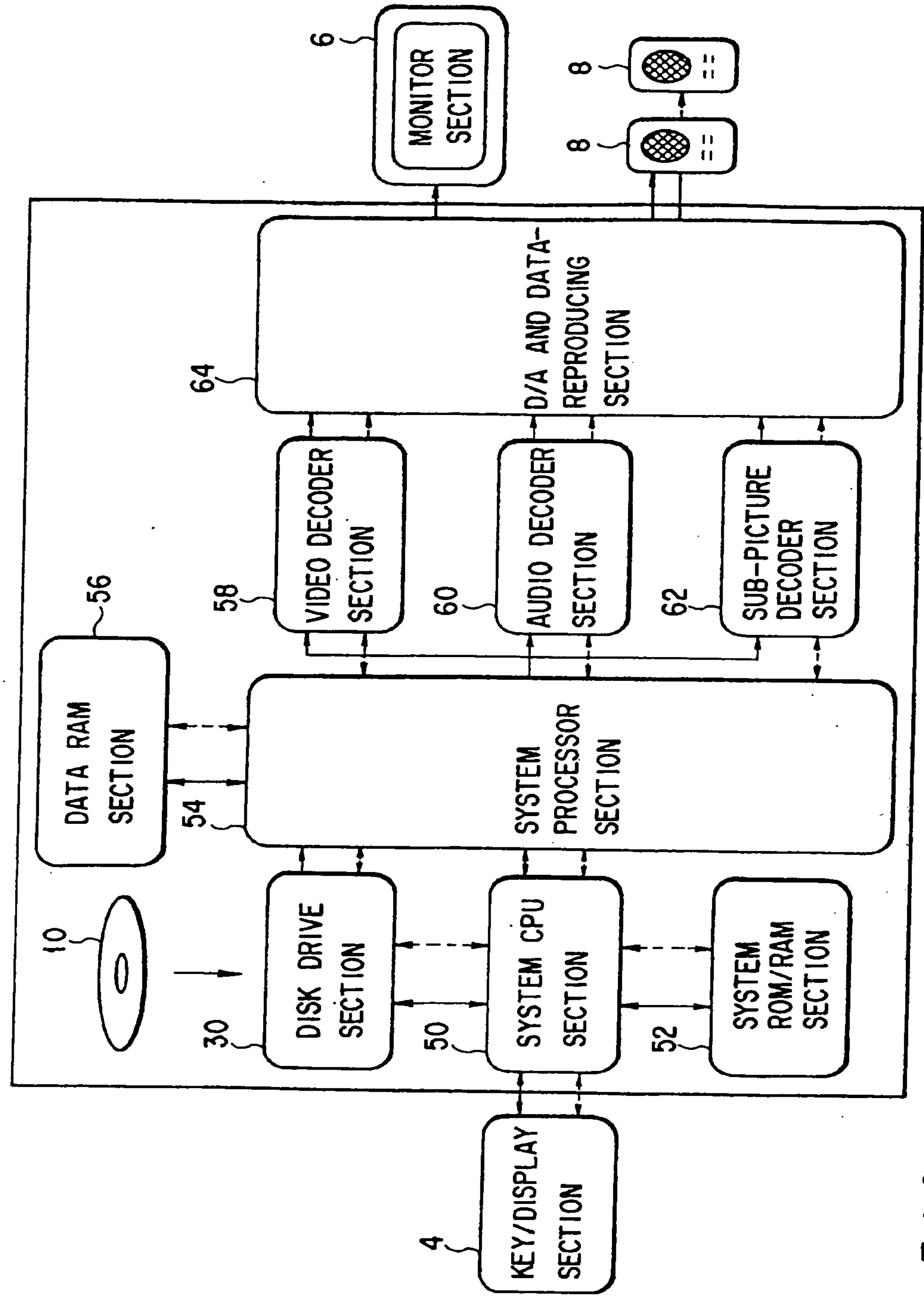
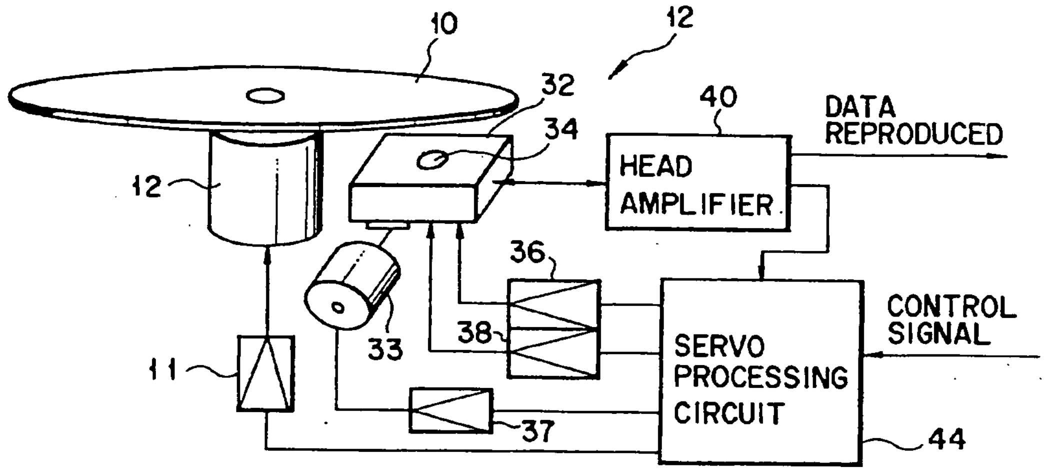
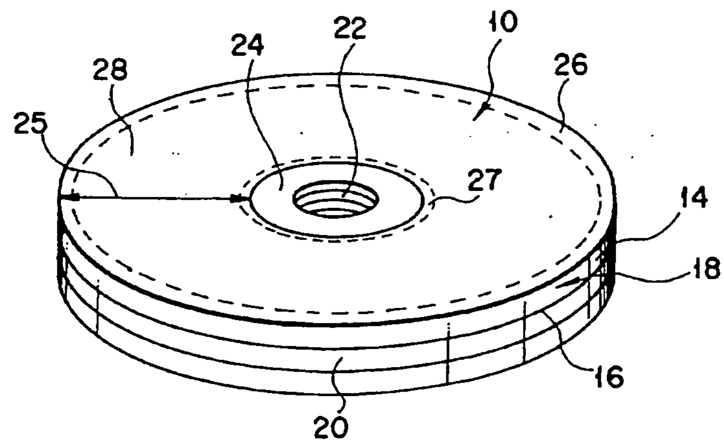

6
MONITOR SECTION
8
8
64
D/A AND DATA-REPRODUCING SECTION
56
DATA RAM SECTION
58
VIDEO DECODER SECTION
60
AUDIO DECODER SECTION
62
SUB-PICTURE DECODER SECTION
54
SYSTEM PROCESSOR SECTION
10
30
DISK DRIVE SECTION
50
SYSTEM CPU SECTION
52
SYSTEM ROM/RAM SECTION
4
KEY/DISPLAY SECTION

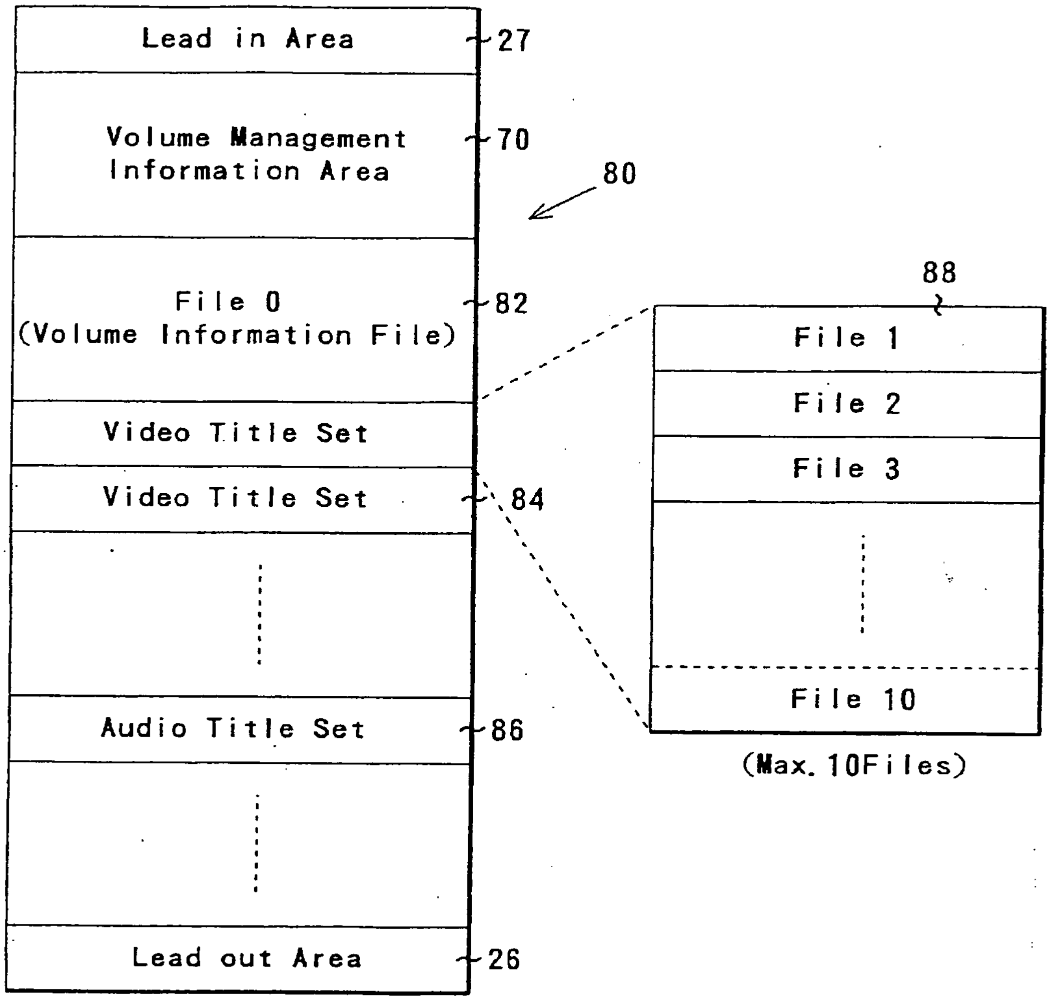
FIG. 1


10
12
32
40
DATA
REPRODUCED
34
HEAD
AMPLIFIER
12
36
CONTROL
SIGNAL
38
SERVO
PROCESSING
CIRCUIT
33
11
37
44

F I G. 2


10
22
24
28
26
25
27
14
18
16
20

F I G. 3


Lead in Area
27
Volume Management
Information Area
70
80
File 0
(Volume Information File)
82
Video Title Set
Video Title Set
84
Audio Title Set
86
Lead out Area
26
88
File 1
File 2
File 3
File 10
(Max. 10Files)

F I G. 4

FIG. 17 is a table showing the parameters of the video title set attribute information described in the TSATRT (FIG. 16);

FIG. 18 is a table showing the parameters of the attribute information of the audio title set (ATS) descried in the TSATR (FIG. 16) contained in the TSATRT (FIG. 5);

FIG. 19 is a diagram depicting the structure of the title set menu program chain information block group (TSMPGCIBTG) contained in the volume information file shown in FIG. 5;

FIG. 20 is a diagram depicting the structure of the title set menu PGC block table (TSMPGCIBT) contained in the volume information file shown in FIG. 5;

FIG. 21 is a table showing the parameters of the video title set menu program chain information block table information (VTSMPGCIBTI) contained in the TSMPGCIBT (FIG. 20), and also the contents of these parameters;

FIG. 22 is a table showing the parameters of the VTSM language block search pointer (VTSMLBSP) contained in the TSMPGCIBT (FIG. 20), and also the contents of these parameters;

FIG. 23 is a diagram illustrating the structure of the video title set menu language block (VTSMLB) contained in the TSMPGCIBT (FIG. 20), and also the contents of these parameters;

FIG. 24 is a table showing the parameters of the VTSM language block information (VTSMLBI) contained in the VTSMLB (FIG. 23), and also the contents of these parameters;

FIG. 25 is a table showing the parameters of the VTS menu program chain information (VTSMPGI) contained in the VTSMLB (FIG. 23), and also the contents of these parameters;

FIG. 26 is a diagram illustrating the structure of the video object included in the volume information file and the title set, both shown in FIG. 4;

FIG. 27 is a diagram representing the structure of one of the packs which constitute the video object illustrated in FIG. 26;

FIG. 28 is a diagram showing the structure of the video title set shown in FIG. 4;

FIG. 29 is a diagram illustrating the relationship between an video object and cells and the relationship between each cell and various packs;

FIGS. 30 and 31 are a flow chart explaining how a volume menu is displayed;

FIGS. 32 and 33 are a flow chart explaining various operations, from the displaying of a title menu to the selection of a title;

FIG. 34 is a diagram illustrating title menus which can be displayed in the monitor section shown in FIG. 1 and can be cyclically switched;

FIG. 35 is a block diagram of an encoder system designed to encode video data, thereby to form a video data file;

FIG. 36 is a flow chart explaining the operation of the encoder system;

FIG. 37 is a flow chart explaining how to form a video data file by combining the video data, audio data and sub-picture data which the encoder system has generated;

FIG. 38 is a block diagram showing a disk formatter system designed to record a formatted video data file on the optical disk;

FIG. 39 is a flow chart explaining a method of generating logic data to be recorded on the disk, by the disk formatter shown in FIG. 38; and

FIG. 40 is a flow chart explaining how to generate physical data from the logic data.

An embodiment of the present invention will now be described, with reference to the accompanying drawings.

FIG. 1 is a block diagram showing an optical disk system designed which is designed to reproduce data from an optical disk and which is an embodiment of the invention. FIG. 2 is a block diagram showing the disk drive section incorporated in the optical disk system. FIG. 3 shows the optical disk loaded in the disk drive section illustrated in FIG. 2.

As shown in FIG. 1, the optical disk system comprises a key/display section 4, a monitor section 6, and a speaker section 8. When a user operates the key/display section 4, the data recorded on an optical disk 10 is reproduced. The data includes video data, sub-picture data and audio data, which are converted into video signals and audio signals. The video signals are supplied to the monitor section 6, and the audio signals to the speaker section 8. The monitor section 6 displays the images represented by the video signals. The speaker section 8 generates the sound represented by the audio signals.

As known in the art, there are optical disks of various structures. The optical disk 10 is, for example, a read-only disk shown in FIG. 3 which has been recently developed and on which data is recorded in high density. As shown in FIG. 3, the optical disk 10 comprises a pair of composite layers 18 and an adhesive layer 20 interposed between the composite disk layers 18. Each disk layer 18 consists of a transparent substrate 14 and a light-reflecting layer (i.e., a recorded layer). The disk layers 18 are positioned such that the light-reflecting layers 16 contact the surfaces of the adhesive layer 20. The optical disk 10 has center hole 22. The disk 10 also has two annular clamping areas 24 on both surfaces, each around the hole 22. It is in the center hole 22 that the spindle of a spindle motor 12 shown in FIG. 2 will be inserted when the disk is loaded in the optical disk system. It is at the clamping area 24 that the disk 10 remains clamped while it is spinning.

As shown in FIG. 3, too, the optical disk 10 has two annular data-recording areas 25 on both surfaces, each around the clamping area 24. Each data-recording area 25 is comprised of a lead-out area 26, a lead-in area 27, and a recorded area 28. The lead-out area surrounds the clamping area 24 and is surrounded by the recorded

area 28, which in turn is surrounded by the lead-out area 26. No data is recorded in the lead-out areas 26 and the lead-in areas 28 in most cases.

Each light-reflecting layer 16 has a track on its outer surface. The track is a continuous spiral track, as in most optical disks of this type. The track is divided into a plurality of sectors. Data is recorded in units, each in one sector. The track corresponds to the recorded area 28, in which management data, video data, sub-picture data and audio data are recorded in the form of pits (i.e., physical changes). Since the optical disk 10 is a read-only one, a spiral train of pits has been formed by a stamper in the surface of each transparent substrate 14. On the surface of the transparent substrate 14 there has been vapor-deposited the light-reflecting layer 16, which serves as a recorded layer 16. No groove (for a track) is formed in the surface of the transparent substrate 14, and only a train of pits is formed as a track in the surface of the transparent substrate 14. This is because the optical disk 10 is a read-only disk.

As shown in FIG. 1, the optical disk system further comprises a disk drive section 30, a system CPU section 50, a system ROM/RAM section 52, a system processor section 54, a data RAM section 56, a video decoder section 58, a audio decoder section 60, a sub-picture decoder section 62, and a D/A and data-reproducing section 64.

As shown in FIG. 2, the disk drive section 30 has a motor drive circuit 11, the spindle motor 12, an optical head 32 (i.e., an optical pickup), a feed motor 33, a focusing circuit 36, a feed motor drive circuit 37, a tracking circuit 38, a head amplifier 40, and a servo processing circuit 44. The optical disk 10 is mounted on the spindle motor 12, which is to be driven by the motor drive circuit 11 and is rotated by the spindle motor 12. The optical head 32 is located below the optical disk 10, for applying a laser beam onto the disk 10. The optical head 32 is mounted on a guide mechanism (not shown). The feed motor drive circuit 37 is provided to supply a drive signal to the feed motor 33. The motor 33 is to driven by the drive signal to move the optical head 32 in the radial direction of the disk 10. The optical head 32 has an objective lens 34 which faces the optical disk 10. The objective lens 34 can be moved along its optical axis in accordance with a driven signal supplied from the focusing circuit 36.

To reproduce the data from the optical disk 10 described above, the optical head 32 applies a laser beam onto the optical disk 10 through the objective lens 34. The lens 34 is minutely moved in the radial direction of the disk 10 in accordance with a drive signal supplied from the tracking circuit 38. The lens 34 is also minutely moved along its optical axis in accordance with a drive signal supplied from the focusing circuit 36, such that its focal point is located at the recorded layer 16 of the disk 10. Therefore, the laser beam forms the smallest beam spot on spiral track (i.e., the train of pits) and the spiral track is traced by the laser beam spot. The laser beam is reflected from the recorded layer 16 and applied back to the optical head 32. The head 32 converts the beam into an electric signal, which is supplied via the head amplifier 40 to the servo processing circuit 44. The circuit 44 generates a focusing signal, a tracking signal and a motor control signal, which are supplied to the focusing circuit 36, the tracking circuit 38 and the motor drive circuit 11, respectively.

The objective lens 34 is thereby moved along its optical axis and in the radial direction of the disk 10, having its focal point located at the recorded layer 16 of the disk 10. The laser beam forms the smallest beam spot on spiral track. In the meantime, the motor drive circuit 11 drives the spindle motor 12, which in turn rotates the optical disk 10 at a predetermined speed. As a result, the beam spot tracks the spiral train of the pits at, for example, a constant linear speed.

Meanwhile, the system CPU section 50 (FIG. 1) supplies a control signal (or an access signal) to the servo processing circuit 44. Upon receipt of the control signal the servo processing circuit 44 supplies a head-moving signal to the feed motor drive circuit 37, which supplies a drive signal to the feed motor 33. The feed motor 33 is thereby driven, moving the optical head 32 in the radial direction of the optical disk 10. The optical head 32 has access to a specified one of the sectors formed on the recorded layer 16 of the disk 10. The data is thereby reproduced from the specified sector, supplied from the head 32 to the head amplifier 40, amplified by the amplifier 40, and output from the disk drive section 30.

The data reproduced is supplied to the data RAM section 56 through the system CPU section 50 and the system processor section 54. The section 50 is controlled by the programs stored in the system ROM/RAM section 52. The system processor section 54 processes the data into video data, audio data and sub-picture data. The video data, the audio data and the sub-picture data are supplied to the video decoder section 58, the audio decoder section 60 and the sub-picture decoder section 62 and decoded by these decoder sections 58, 60 and 62, respectively. The D/A and data-reproducing section 64 converts the vide data, the audio data and the sub-picture data, all decoded, to a video signal, an audio signal and a sub-picture signal which are analog signals. These signals are mixed in the D/A and data-reproducing section 64. The video signal and the sub-picture signal are supplied to the monitor section 6, and the audio signal to the speaker section 8. The monitor section 6 displays an image generated from the video signal and the sub-picture signal. The speaker section 8 generates the sound represented by the audio signal.

The operation of the optical disk system (FIG. 1) will be explained later in more detail, with reference to the logic format of the optical disk 10.

The recorded area 28 of the optical disk 10, provided between the lead-out area 26 and the lead-in area 27, has the volume and file structure shown in FIG. 4. This structure complies with specific logic format standards, such as Micro UDF and ISO 9660. As seen from FIG. 4, the volume and file structure has a directly structure and consists of a volume management information area 70

and, a file area 80 which includes, a volume information file 82, video title sets 84 and/or audio title sets 86. These areas, files and title sets are aligned on the boundary between logical sectors. The volume management information 70 stores contents which are defined in the above described standard. The file area 80 stores video data, audio data, and data for managing the video data and the audio data. That is, the video title set 84 stores video, audio and sub-picture data, the audio title set stores audio data and the file 82 stores management data related to the video and audio title sets.

The volume management information area 70 is equivalent to the root directory which has been prepared in compliance with both Micro UDF and ISO 9660. Described in the area 70 are a path table and directory codes. The video title sets 84 and the audio title sets 86 exist in the root directly and have directory names assigned to them. Each of video title sets 84 consists of a plurality of video files 88, and each audio title set 86 consists of a plurality of audio files 88. Each of the video and audio files 88 has a size not exceeding 1 GB (2^{30} bytes). Each of the title sets 84 and 86 consists of at least one files 88, maximum ten files, and therefore has a size equal of at least 1 GB or more, maximum 10 GB.

The volume information file 82, which is read out through the volume management information area 70 in which the path table and directory codes are described, has regions, as shown in FIG. 5, each region being aligned on the boundary between logical sectors. More specifically, the volume information file 82 is divided into two main regions, i.e., a management region 82-1 and a menu data region 82-2. The region 82-1 comprises one file manager, three tables and one table group, which are provided for managing the entire volume information file. The region 82-2 comprises of one menu and one menu group, which are provided for forming a menu by using video, audio and sub-pictures or the like. To be more precise, the management region 82-1 is formed of a volume information file manager (VMIFM) 91, a text information table (TXTIT) 92, a title set information search pointer table (TSISPT) 93, a title set attribute table (TSATRT) 94, and title set menu program chain information block table group 95 (TSMPGCIBTG), while the menu data region 82-2 is formed of a video object (VOBVMM) 96 for the volume menu and a video object (VOBTSM) for the first to n-th title sets #1 to #n. As will be described later, video data, sub-picture data and audio data which constitute a menu are stored in the video object (VOBVMM) 96 and each of the video objects (VOBTSMs) 1 to n) 97.

The menu data region 82-2 comprises audio objects in addition to the video objects 96 and 97. Of these audio objects, some are used as audio data items for title set menus, some other are used as video data items for playing back the stories of the titles stored in the title sets 84 and 86, and the remaining ones are used as audio data items for playing back tunes of various title.

The volume information file 82 has a file size not exceeding 1 GB. The volume information file manager (VMIFM) 91 of the volume information file 82 is referred to, in order to acquire the title sets 84 and 86.

As shown in FIG. 5, the volume information file manager (VMIFM) 91 consists of three tables, i.e., a volume information file management table (VMIFMT) 101, a title search pointer table (TSPT) 102, and a volume menu program chain information block table (VMMPGCIBT) 104, each table being aligned on the boundary between logical sectors.

In the volume information file management table (VMIFMT) 101 there are described various information items concerning the volume information file 82. Among these information items are: a volume information file identifier (VMIFID); the size of the volume information title, which is described as number of logical sectors; the start and end addresses of each table; and attribute information provided on the video object (VOBVMM) 96 for the volume menu and representing the attributes of the video, audio data and sub-picture data for the volume menu. To be more specific, the identifier (VMIFID) identifying the volume information file, the size (SZVMIF) expressing the size of the volume information file in terms of the number of sectors, and volume category (VMCAT) indicating whether the data of this volume can be copied or not. Also described in the volume information file management table (VMIFMT) 101 are: the start address (SATXTIT) of the text information table (TXTIT) 92; the start address (SATSISPT) of the title set information search pointer table (TSISPT) 93; the start address (SATSATRT) of the title set attribute table (TSATRT) 94; the start address (SATSMPGCIBTG) of the title set menu program chain information block table group (TSMPGCIBTG) 95; and the start address (SAVOBVMM) of the video object (VOBVMM) 96 for the volume menu.

Further described in the volume information file management table (VMIFMT) 101 are: the end address (EAVMIFMT) of the volume information file management table (VMIFMT) 101; the start address (SATSPT) of the title search pointer table (TSPT) 102; the start address (SAVMMPGCIBT) of the volume menu program chain information block table (VMMPGCIBT) 104; the end address (EAVMMPGCIBT) of the volume menu program chain information block table (VMMPGCIBT) 104. Still further described in the volume information file management table (VMIFMT) 101 are: the video attribute (VMMVATR) for the volume menu, such as the attribute of the video compression mode; the number (VMMNAST) of the audio streams for the volume menu; the audio stream attribute (VMMAATR) for the volume menu, such as the attribute of the audio coding mode; the number (VMMNSPST) of the sub-pictures or the volume menu; the sub-picture stream attribute (VMMSPATR) for the volume menu, such as the attribute of the sub-picture coding mode; and the sub-picture palettes (VMMSPPLT) for the volume menu. In the volume information file management table (VMIFMT) 101, start addresses and end addresses are almost expressed as the relative logic sector numbers, each indicating the position which one logic sector assumes with respect to the first logic sector